(1)

RPT-1177

PROPERTY OF ENGINEERING
TEST EQUIPMENT
OSLEY, DIV. OF AVCO
ITEM 1 COPY 1

Babcock

AUDIO FREQUENCY CODERS

BCC-6D AND BCC-6E

OPERATION AND MAINTENANCE INSTRUCTIONS

BABCOCK ELECTRONICS CORPORATION

Aerospace Division

(1)
(RPT-1177B)

PROPERTY OF ENGINEERING
TEST EQUIPMENT
CROSLEY, DIV. OF AVCO
ITEM 1 COPY 1

(BEC REPORT #1177)

HANDBOOK OF OPERATION AND ~~MAINTENANCE~~ INSTRUCTIONS FOR BCC-6D AND BCC-6E AUDIO FREQUENCY CODERS

15 January 1962
Revision A, July 1963
Revision B, August 1963

TABLE OF CONTENTS

Section			Page
I	GENERAL DESCRIPTION		1
	1-1	Purpose of Handbook	1
	1-2	Purpose of Equipment	1
	1-3	General Principles of Operation	1
	1-4	Specifications	1
II	INSTALLATION AND OPERATION		4
	2-1	Installation	4
	2-2	Preoperational Test	4
	2-3	Operation	6
III	THEORY OF OPERATION		7
	3-1	Block Diagram Analysis	7
	3-2	Brief Theory of Operation	7
IV	MAINTENANCE		9
	4-1	General	9
	4-2	Alignment Procedure	9
	4-3	Troubleshooting Procedure	11
	4-4	Voltage and Resistance Measurements	12
V	DIAGRAMS		14
	5-1	General	14
	5-2	Diagrams	14
VI	PARTS LIST		21
	6-1	General	21
	6-2	Parts List	21

LIST OF ILLUSTRATIONS

Figure		Page
1	BCC-6D and BCC-6E Audio Frequency Coders	0
2	Block Diagram, BCC-6D and BCC-6E	3
3	Operating Controls	5
4	Alignment Adjustments	10
5	Outline Dimensional Diagram, BCC-6D Audio Frequency Coder	15/16
6	Outline Dimensional Diagram, BCC-6E Audio Frequency Coder	17/18
7	Electrical Schematic Diagram, BCC-6D and BCC-6E Audio Frequency Coder	19/20

LIST OF TABLES

Table		Page
I	Specifications, BCC-6D and BCC-6E Audio Frequency Coders	1
II	Test Equipment Required	4
III	BCC-6D and BCC-6E Operating Controls	5
IV	BCC-6D and BCC-6E Alignment Data	9
V	BCC-6D and BCC-6E Troubleshooting Chart	11
VI	BCC-6D and BCC-6E Voltage and Resistance Measurements	12
VII	Replaceable Electronic Components	21

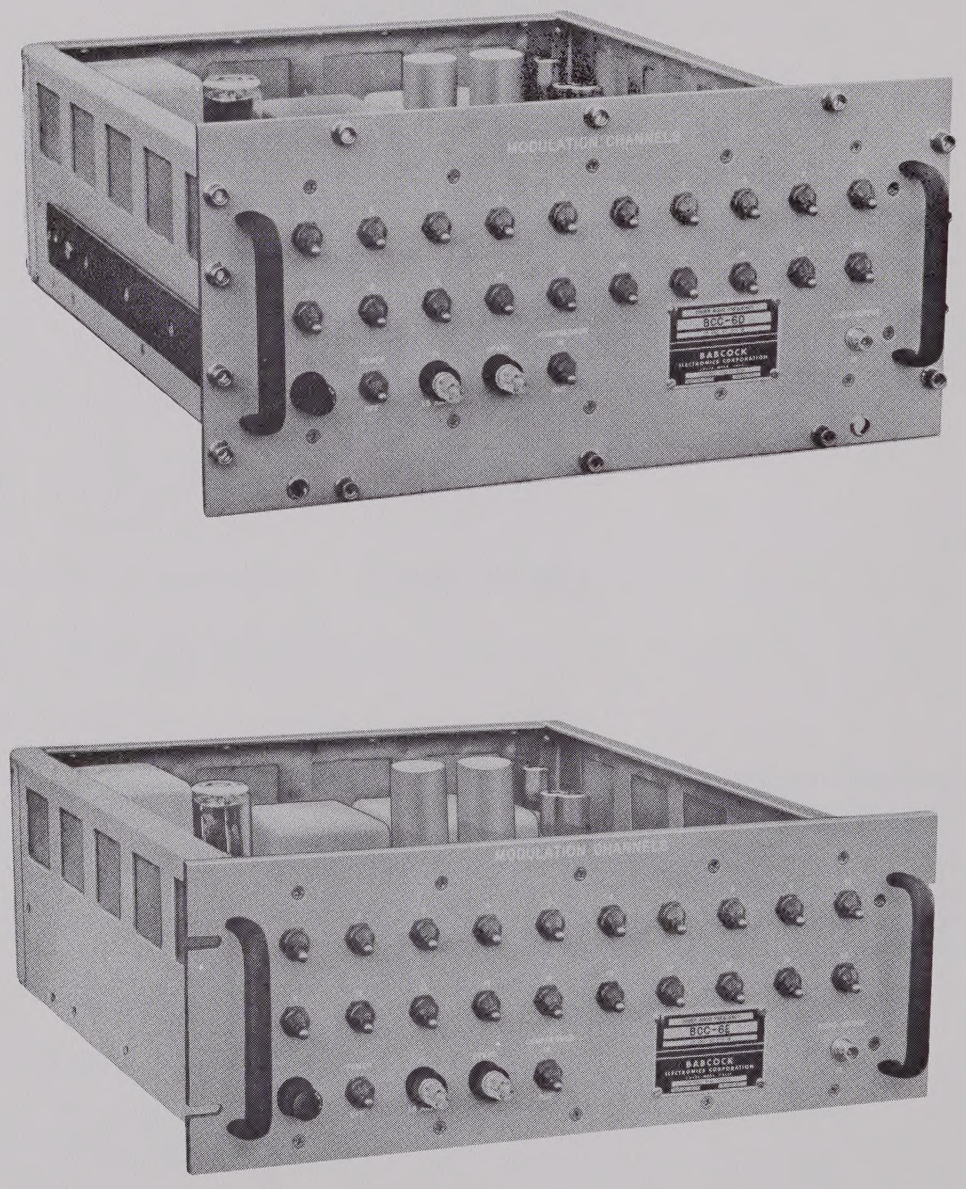

Figure 1. BCC-6D (Top) and BCC-6E Audio Frequency Coders

SECTION I

GENERAL DESCRIPTION

1-1 PURPOSE OF HANDBOOK

This publication is issued as a handbook of operation and maintenance instructions for the BCC-6D and BCC-6E Audio Frequency Coders (figure 1) and is intended to familiarize operating and maintenance personnel with the overall theory, operation, and maintenance of the coders.

1-2 PURPOSE OF EQUIPMENT

The BCC-6D and BCC-6E Audio Frequency Coders are identical in operation. Where the BCC-6D is designed to be mounted and secured with fourteen captive screws, the BCC-6E is designed for mounting in a standard nineteen-inch relay rack. The coders are capable of producing the first twenty IRIG audio tones (table I) with the output of each channel variable from 0 to 2.0 volts. Up to six tones may be produced simultaneously in either compressed or non-compressed form. The coder output is used to modulate a signal generator or radio transmitter or for other suitable test applications.

1-3 GENERAL PRINCIPLES OF OPERATION

Figure 2 is a simplified block diagram of the BCC-6D and BCC-6E Audio Frequency Coders. Accurate audio oscillators are switched on to produce the required IRIG audio tones. Outputs of the oscillators feed to voltage divider networks to assure a uniform output amplitude regardless of the number of channels operating. The divider networks are controlled by a compressor switch to select the operating mode. The combined audio is amplified and matched at the output with a cathode follower circuit.

1-4 SPECIFICATIONS

Table I presents the specifications for the physical and electrical characteristics of the BCC-6D and BCC-6E Audio Frequency Coders.

TABLE I. SPECIFICATIONS, BCC-6D AND BCC-6E AUDIO FREQUENCY CODERS

CHARACTERISTICS	SPECIFICATIONS	
Physical	BCC-6D	BCC-6E
Height	8-3/4 inches	7 inches
Width	19 inches	19 inches
Depth	23 inches	23 inches
Weight	75 pounds	75 pounds

TABLE I. SPECIFICATIONS, BCC-6D AND BCC-6E AUDIO FREQUENCY CODERS (CONT)

CHARACTERISTICS	SPECIFICATIONS
Electrical	
Input Power	
Voltage	115 volts ac ±10%
Frequency	60 cps ±10%
Total Power Consumption	100 watts
Output Characteristics	
Impedance	500 ohms
Amplitude	Each channel variable from 0 to 2.0 volts ac rms across 500 ohms
Frequency range	7.4 to 74 kc
Maximum simultaneous channels	6
20 Preset IRIG Channel Frequencies (±1%)	
Channel 1	7,500 cps
Channel 2	8,460 cps
Channel 3	9,540 cps
Channel 4	10,760 cps
Channel 5	12,140 cps
Channel 6	13,700 cps
Channel 7	15,450 cps
Channel 8	17,430 cps
Channel 9	19,600 cps
Channel 10	22,170 cps
Channel 11	25,010 cps
Channel 12	28,210 cps
Channel 13	31,830 cps
Channel 14	35,900 cps
Channel 15	40,490 cps
Channel 16	45,680 cps
Channel 17	51,520 cps
Channel 18	58,120 cps
Channel 19	65,560 cps
Channel 20	73,950 cps

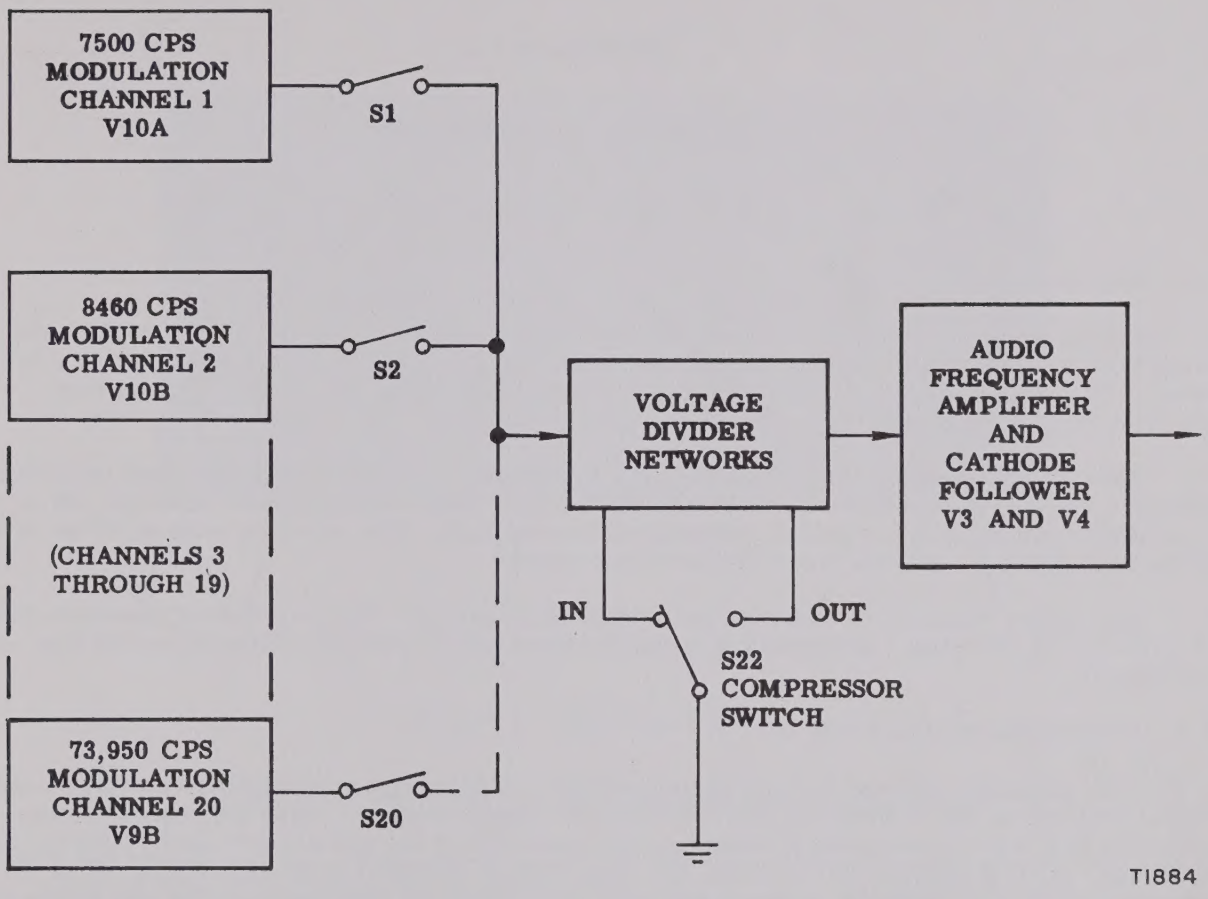

Figure 2. Block Diagram, BCC-6D and BCC-6E

SEP 2 8 1984

SECTION II

INSTALLATION AND OPERATION

2-1 INSTALLATION

During unpacking of the BCC-6D or BCC-6E Audio Frequency Coders, care should be exercised to avoid damaging the equipment. Observe all unpacking instructions on the shipping container. Remove all miscellaneous packing and moisture absorbing material. Check packing material carefully for small items and mounting hardware.

The BCC-6D is designed for mounting in a Babcock BCY-10 or similar electrical equipment cabinet. The fourteen captive screws align with threaded holes in the cabinet. The BCC-6E is designed for mounting in a standard, nineteen-inch relay rack. The mounting slots on either side of the front panel are manufactured on four-inch centers.

The coders require 115 volts, 60 cps, single phase power. The units have a maximum power requirement of 100 watts. Power is connected to receptacle J1 (AN3102-10SL-3P) on the rear of the chassis.

2-2 PREOPERATIONAL TEST

This paragraph outlines the test equipment and test procedures necessary to perform a preoperational test on the BCC-6D or BCC-6E Audio Frequency Coders. After the coder has been installed, this test is performed to assure proper operation of the unit prior to performing normal operation. If all indications are normal, the coder may be assumed to be operational. If an incorrect indication is observed, refer to section IV to correct the malfunction. The test equipment required is listed in table II. Location of operating controls is shown in figure 3 and referenced in table III.

TABLE II. TEST EQUIPMENT REQUIRED

NAME	TYPE	ALTERNATE
Frequency Counter	HP-524C (Hewlett-Packard) (FSN 6625-793-1348)	MODEL 7573 (Beckman/Berkeley)
Oscilloscope	MODEL 535 (Tektronix)	Equivalent
AC VTVM	HP-410B (Hewlett-Packard) (FSN 6625-360-2493)	Equivalent
Load, Resistive	500 ohm ±5%, 2W	

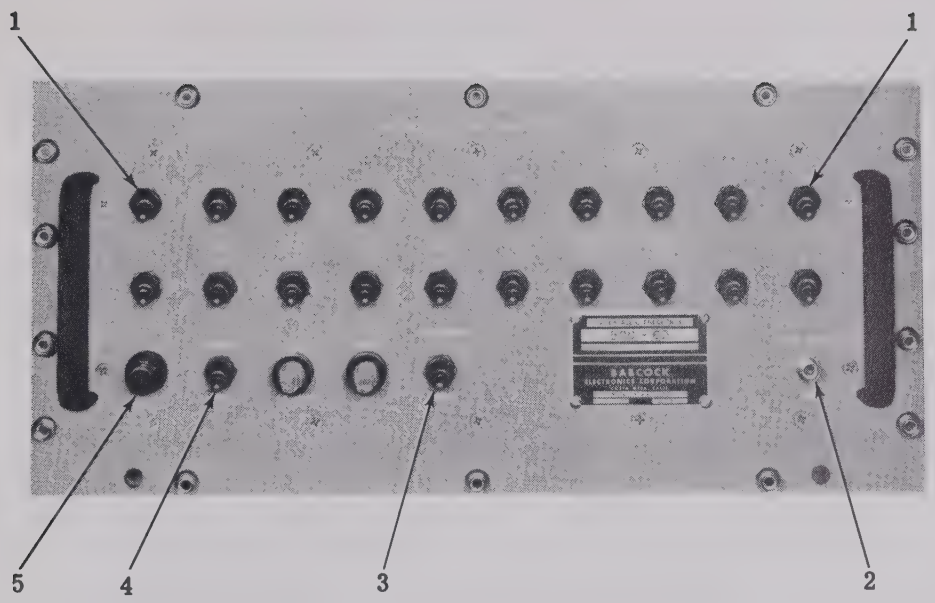

Figure 3. Operating Controls

TABLE III. BCC-6D AND BCC-6E OPERATING CONTROLS

INDEX NO.	CONTROL OR INDICATOR	FUNCTION
1	MODULATION CHANNELS, Switches 1 through 20	Activates associated audio tone oscillator.
2	AUDIO OUTPUT Jack J2	Provides front panel connection to coder audio output.
3	COMPRESSOR IN-OUT Switch	Compensates for gain variations as additional channels are activated. Switch is left in IN position for most applications.
4	POWER OFF Switch	Controls application of 115 volt a-c power to coder.
5	Power Indicator	Illuminates when 115 volt a-c power applied to coder.

To conduct the preoperational test on the BCC-6D or BCC-6E, perform the following steps:

a. Activate all test equipment and allow time for warmup.

b. Connect Frequency Counter and AC VTVM to AUDIO OUTPUT connector J2 with 500 ohm load in parallel with input to AC VTVM.

c. Place POWER switch to up position. Power indicator should illuminate.

d. Place COMPRESSOR switch to OUT position.

e. Place MODULATION CHANNELS 1 switch to up position and all other MODULATION CHANNELS switches to down position. Frequency Counter should register 7,500 cps ±1 percent. AC VTVM should indicate 1.5 ±0.03 volts rms.

f. Place MODULATION CHANNELS 1 switch to down position. Repeat step e above for MODULATION CHANNELS 2 through 20 in succession. Examine Frequency Counter display for compliance with respective IRIG channel audio frequency (see table I) ±1 percent. AC VTVM should indicate 1.5 ±0.03 volts rms.

g. Disconnect Frequency Counter and AC VTVM from AUDIO OUTPUT receptacle J2.

h. Connect Oscilloscope vertical input to AUDIO OUTPUT receptacle J2.

i. Place COMPRESSOR switch to IN position. A complete wave range should appear on Oscilloscope.

j. Place any six MODULATION CHANNELS switches to up position. Oscilloscope should indicate peak-to-peak amplitude of 4.2 ±0.2 volts.

2-3 OPERATION

Operation of the BCC-6D or BCC-6E Audio Frequency Coders consists of making the proper external cable connections, turning on the equipment, and operating the MODULATION CHANNELS switches in a manner appropriate to the application. Remote operation of the units is possible by grounding appropriate pins in connector J4 with switches or other external means. See applicable equipment manuals for specific operation with associated equipment.

SECTION III

THEORY OF OPERATION

3-1 BLOCK DIAGRAM ANALYSIS

See paragraph 1-3 for a block diagram analysis of the BCC-6D or BCC-6E Audio Frequency Coders.

3-2 BRIEF THEORY OF OPERATION

The BCC-6D and BCC-6E Audio Frequency Coders are used to generate the first 20 standard IRIG audio frequencies. The audio frequencies generated may be used individually or in coded combinations consisting of not more than six of the 20 frequencies available. (See figure 7.) The audio frequencies are generated by 20 Colpitts-type, tuned-plate oscillators energized individually and referred to as modulation channels. The oscillator outputs are applied to voltage divider networks controlled by COMPRESSOR switch S22. When S22 is in the IN position the voltage divider networks function to provide a constant amplitude output regardless of the number of modulation channels used. When S22 is in the OUT position the amplitude of the signal applied to the audio frequency amplifiers is a function of the number of channels being used. After amplification, the composite audio signal (one or more frequencies) is applied to a cathode follower.

The 20 audio-frequency, Colpitts-type oscillators produce 20 outputs in a range from 7,500 to 73,950 cycles per second. Channel data is listed in table I. The operation of all oscillators is identical therefore, only the channel 1 oscillator is described in detail.

The channel 1 oscillator consists of triode V10A, tank circuit Z1, and switch S1. When the coder is energized, 108 volts dc is applied to the plate of V10A through load resistor R77. The oscillator is actuated by closing switch S1. The output frequency of the channel 1 oscillator is 7,500 cps ±1 percent. The frequency adjustment for the channel 1 oscillator is variable capacitor C40, which is in parallel with tank circuit Z1. The output of the oscillator is taken from the wiper of potentiometer R77 and is applied through C41 to the voltage divider network of R78 and R79. When S1 is closed to energize the channel 1 oscillator, a path is completed from the power supply through R98 and the coil of relay K1 to ground. Relay K1 is energized, connecting the output from the junction of R78 and R79 to the input circuit of the audio-frequency amplifier. When S1 is open, the K1 contacts open to remove the connection to the voltage divider networks, and oscillator V10A is disabled. Each oscillator may also be energized by connecting a remote control box to remote control receptacle J4 on the rear of the coder component. If the remote control facilities are not available, energizing of individual oscillator channels may be accomplished by using a suitable grounding strap and grounding appropriate pins of J4.

The output of each oscillator is applied to a separate voltage divider network. All 20 channels are arranged in the same fashion. With COMPRESSOR switch S22 in the IN position, the voltage divider ratio for each oscillator is 100:1. The output signal from each oscillator to the audio-frequency amplifier will have the same amplitude whether one oscillator or more are energized.

With the COMPRESSOR switch in the OUT position, R79 is removed from the circuit and replaced by R2. If only channel 1 is oscillating, the 100:1 ratio remains, as the voltage divider network is made up of R78 and R2. The output is identical to that obtained with channel 1 energized

and the COMPRESSOR switch in the IN position. If both channel 1 and channel 2 are oscillating, the voltage divider network consists of the parallel arrangement of R78 and R80 (considering channels 1 and 2 as a common source) in series with R2. The effective voltage divider ratio under this condition is 50:1, which produces an increased level to the audio-frequency amplifier. Each oscillator that is added when the COMPRESSOR switch is in the OUT position increases the total effective output to the audio-frequency amplifier.

The a-f amplifier, V3, and the cathode follower, V4, conduct continuously when the coder unit is energized. When a signal from the oscillator section is applied through the voltage divider networks to the grid of V3A, Class A amplification occurs. The amplified signal is developed across plate load resistor R5 and coupled to the grid of V3B through capacitor C5. The signal is amplified again by V3B and fed to the cathode follower through capacitor C6. The cathode of V4 is current-coupled to the cathode of V3A through common-cathode resistor R6. Current-coupling from V4 to V3A thus tends to reduce the grid-to-cathode signal at V3A, thereby limiting and stabilizing gain through V3 and V4. The value of the output at jacks J3 and J4 is 1.5 ±0.03 volts rms, when the COMPRESSOR switch is in the IN position.

The power supply for the coder provides full-wave rectification of the 115 volt ac, single-phase, 60 cycle input power when power switch, S21, is closed. An inductive-capacitive filter removes the 120 cps ripple frequency from the d-c output. Unregulated d-c voltage is applied to V2, V3, and V4. Resistor R1 and VR tube V2 supply 108 volts regulated dc to the plates of V5 through V14.

BABCOCK ELECTRONICS CORPORATION

AEROSPACE DIVISION	*1640 Monrovia Avenue, Costa Mesa, California* *Phone: (714) 548-0611 TWX: (714) 642-1331*
RELAYS DIVISION	*3501 Harbor Blvd., Costa Mesa, California* *Phone: (714) 546-2711 TWX: (714) 546-0445*
ORLANDO DIVISION	*2525 West Shader Road, Orlando, Florida* *Phone: (305) 295-2410 TWX: (305) 275-1491*
WASHINGTON OFFICE	*1712 Eye Street, N.W., Suite 802, Washington, D.C.* *Phone: (202) 298-6880 TWX: (202) 965-0482*
HUNTSVILLE OFFICE	*Sahara Office Park, Suite 120, Huntsville, Alabama* *Phone: (205) 881-3780 TWX: (810) 726-5104*

92626
714540 1234